CLAIMS

1. A method of shutting down an operating fuel cell system, said method comprising:

configuring said system to include:

at least one fuel cell comprising an anode, a cathode and a membrane disposed between said anode and cathode;

an anode flowpath configured to couple said anode to a fuel source;

a cathode flowpath configured to couple said cathode to an oxygen source, said cathode flowpath including a recirculation loop disposed therein; and

a purge valve fluidly coupled to said anode;

decoupling said anode from said fuel source;

recycling fluid disposed in said cathode flowpath through said recirculation loop;

introducing fuel from said fuel source into said recirculation loop;

reacting said fuel with said recycled fluid until a voltage measured across said fuel cell reaches a predetermined level;

decoupling said fuel source from said recirculation loop to discontinue flow of said fuel thereto; and

introducing a purging fluid into said anode through said purge valve such that any fluid previously resident in said anode is substantially purged therefrom.

2. The method of claim 1, wherein said purging fluid is diverted from said cathode flowpath upstream of said cathode and downstream of said oxygen source.

3. The method of claim 1, wherein said purging fluid is diverted from said cathode flowpath downstream of said cathode and upstream of a cathode exit valve.

4. The method of claim 1, wherein said purging fluid comprises a substantially oxygen-depleted fluid.

5. The method of claim 4, wherein said purging fluid comprises said substantially oxygen-depleted fluid introduced from at least a portion of said cathode flowpath followed by air introduced from said oxygen source.

6. The method according to claim 1, wherein said recycling further comprises closing a cathode exit valve and opening a cathode flowpath recycle valve, both disposed within said recirculation loop.

7. The method according to claim 1, wherein said purge valve is fluidly coupled to said cathode flowpath upstream of said cathode.

8. The method according to claim 1, wherein said introducing of said purging fluid is effected by closing a fuel inerting valve and opening said purge valve.

9. The method according to claim 1, where said predetermined voltage level across said fuel cell is no greater than 0.4 volts.

10. A method of shutting down an operating fuel cell system, said method comprising:

configuring said system to include:

at least one fuel cell comprising an anode, a cathode and a membrane disposed between said anode and cathode;

an anode flowpath configured to couple said anode to a fuel source;

a cathode flowpath configured to couple said cathode to an air source, said cathode flowpath including a recirculation loop disposed therein;

a plurality of valves comprising:

at least one valve disposed within said recirculation loop to selectively allow recirculation of fluid therethrough;

a purge valve that fluidly couples said cathode flowpath upstream of said cathode to said anode flowpath;

a fuel inerting valve that configured to couple said cathode flowpath to said fuel source; and

a fuel supply valve fluidly disposed in said anode flowpath;

a pressure source coupled to said air source; and

a device configured to facilitate a reaction between fuel and air;

decoupling said anode from said fuel source;

recycling fluid disposed in said cathode flowpath through said recirculation loop;

introducing fuel from said fuel source into said recirculation loop;

reacting said fuel with said recycled fluid until a voltage measured across said fuel cell reaches a predetermined level;

decoupling said fuel source from said recirculation loop to discontinue flow of said fuel thereto; and

sequentially introducing a substantially oxygen-depleted fluid from at least a portion of said recirculation loop and air from said air source into said anode through said purge valve such that any fluid previously resident in said anode is substantially purged therefrom.

11. A method of starting a fuel cell system, said method comprising:

configuring said system to include:

at least one fuel cell comprising an anode, a cathode and a membrane disposed between said anode and cathode;

an anode flowpath configured to couple said anode to a fuel source;

a cathode flowpath configured to couple said cathode to an oxygen source, said cathode flowpath including a recirculation loop disposed therein; and

a purge valve fluidly coupled to said anode;

recycling fluid disposed in said cathode flowpath through said recirculation loop;

introducing said fuel into said recirculation loop;

reacting said fuel with said recycled fluid in said device until a voltage measured across said fuel cell reaches a predetermined level;

decoupling said fuel source from said recirculation loop to discontinue flow of said fuel thereto;

filling said anode with fuel; and

introducing air into said cathode to displace a substantially oxygen-depleted fluid produced during said reacting.

12. The method according to claim 11, wherein the presence of said substantially oxygen-depleted fluid occasions a negative voltage across said at least one fuel cell prior to said filling said anode with fuel.

13. The method according to claim 11, further comprising bleeding fluid from said oxygen source into said anode to facilitate low temperature starting.

14. The method according to claim 11, further comprising bleeding fuel from said fuel source into said cathode to facilitate low temperature starting.

15. A device comprising:

at least one fuel cell comprising an anode, a cathode and a membrane disposed between said anode and cathode;

an anode flowpath configured to couple said anode to a fuel source;

a cathode flowpath configured to couple said cathode to an oxygen source, said cathode flowpath including a recirculation loop disposed therein;

a plurality of valves at least some of which are configured to establish fluid communication between said anode flowpath and said cathode flowpath, said plurality of valves comprising:

a fuel supply valve disposed between said fuel source and said anode;

at least one valve disposed in said recirculation loop to selectively allow recycling of fluid therethrough;

a fuel inerting valve disposed between said anode flowpath and said cathode flowpath to allow selective introduction of fuel into said cathode flowpath; and

a purge valve disposed between said anode flowpath and said cathode flowpath, said purge valve disposed upstream of said cathode; and

a reactor disposed in said cathode flowpath, said reactor configured to promote reaction between fuel and oxygen such that upon transiently operating said fuel cell, said reactor combines fuel and fluid recycled through said recirculation loop to reduce voltage across fuel cell, thereby enabling at least one of air or said recycled fluid to purge one of said anode or cathode.

16. A device according to claim 15, wherein said device further comprises a power conversion mechanism configured to take electricity generated by said fuel cell system and convert it to motive power.

17. A device according to claim 16, wherein said device further comprises a vehicle configured to house said fuel cell system and said power conversion mechanism, said vehicle movably responsive to said motive power generated in said power conversion mechanism.

18. A method of transiently operating a fuel cell system, said method comprising:

configuring said system to include:

at least one fuel cell comprising an anode, a cathode and a membrane disposed between said anode and cathode;

an anode flowpath configured to couple said anode to a fuel source;

a cathode flowpath configured to couple said cathode to an oxygen source, said cathode flowpath including a recirculation loop disposed therein; and

an anode purge flowpath configured to selectively couple said recirculation loop to said anode;

selecting from one of two transient operating modes, said first mode comprising starting up said system, and said second mode comprising shutting down said system;

recycling fluid disposed in said cathode flowpath through said recirculation loop;

reacting fuel with said recycled fluid until a voltage measured across said fuel cell reaches a predetermined level;

discontinuing said reacting; and

introducing a fluid into at least one of said anode or said cathode such that any fluid previously resident therein is substantially purged therefrom.

19. The method according to claim 18, wherein said anode purge flowpath comprises a purge valve disposed therein to effect said selective coupling.

20. The method according to claim 18, wherein said selecting comprises selecting said first mode of operation.

21. The method according to claim 20, further comprising filling said anode with fuel after said reacting has been discontinued.

22. The method according to claim 21, further comprising flowing air through said cathode once said anode has been filled with fuel.

23. The method according to claim 22, wherein said flowing air through said cathode comprises disabling said recirculation loop.

24. The method according to claim 18, wherein said selecting comprises selecting said second mode of operation.

25. The method according to claim 24, wherein said introducing a fluid into at least one of said anode or said cathode comprises sequentially introducing into said anode a substantially oxygen-depleted fluid from at least a portion of said cathode flowpath followed by air from said oxygen source.

26. The method according to claim 25, further comprising decoupling said anode from said fuel source prior to recycling fluid disposed in said cathode flowpath through said recirculation loop.

27. The method according to claim 26, further comprising stopping fluid flow through said cathode flowpath once said anode is substantially purged.